B1 end essentially of one or more fluorine-containing compounds, an optional inert carrier gas and chlorine, the [etching gas] system of etching agents being free of nitrogen.

Sub B3 --22. A process for etching a pattern of exposed areas of an organic ARC, comprising exposing the ARC to an oxygen-free system of etching agents in an ionized state in a reaction chamber of a plasma generating device, the system of etching agents B2 including one or more fluorine-containing compounds, chlorine, and an inert carrier gas, wherein a photoresist layer forming the pattern of exposed areas is disposed on the organic ARC, and wherein the organic ARC is selectively etched and the photoresist is substantially preserved such that lateral degradation of the photoresist layer forming the pattern of exposed areas is substantially prevented.--

REMARKS

Reconsideration of the August 25, 1999 Official Action is respectfully requested. The various issues raised in the Official Action are discussed in the order in which they appear in the Official Action.

Claim 14 was rejected under 35 U.S.C. §112, second paragraph, for the reasons set forth in paragraph 3, on page 2 of the Official Action. Claim 14 has been amended in a manner which addresses the Examiner's comments. Accordingly, withdrawal of this ground of rejection is respectfully requested.

Claims 1-4, 6, 8-12, 14-17, 19 and 20 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 5,554,560 ("Hsue") in view of U.S. Patent No. 5,514,247 ("Shan"). The reasons for the rejection are set forth in paragraph 5, on pages 3-4 of the Official Action. This rejection is respectfully traversed.

Independent Claim 1 sets forth a process for removing an organic ARC on a metallic layer. The process comprises exposing the ARC to an oxygen-free system of etching agents in an ionized state in a reaction chamber of a plasma generating device. The system of etching agents includes one or more fluorine-containing compounds, chlorine and an optional inert carrier gas. As described in the specification, one aspect of this etching process is that it can provide enhanced etch selectivity between the organic ARC layer and the photoresist layer in comparison to conventional oxygen-based plasma-etch chemistries (page 3, lines 11-20). The claimed method is not suggested by the cited references.

In the Official Action, Hsue is cited for a disclosure of etching a polymer ARC on a conductive layer with CHF_3+CF_4+Ar (Official Action at page 3). Shan is cited for a disclosure of adding 5 to 25 sccm Cl_2 and HCl to a dielectric etch gas mixture in order to form a volatile compound with the underlying metal (Official Action at page 4). In combining Hsue with Shan, the Official Action alleges that it would have been obvious to add chlorine to Hsue's etching gas mixture "because chlorine helps to dissociate C-F bonds in the dielectric etch process chemistry and remove polymer residue at the surface of silicon exposed upon etching through the dielectric layer."

Contrary to the position taken in the Official Action, Hsue does not provide an ARC on a conductive layer. Instead, the "optional" ARC in Hsue is provided on an oxide/nitride layer. That is, Hsue discloses a method for planarizing a field-oxide structure grown by the local oxidation of silicon. A local field oxide is first grown on a silicon substrate having a patterned nitride layer (column 4, lines 1-10). A planarization layer 20 (which may be an ARC) is then spun over the oxide/nitride structure (column 4, lines 45-57). That structure is then plasma etched using a mixture of CHF_3, CF_4, and Ar (column 5, lines 10-29). Accordingly, even if a polymer ARC is used for the planarization layer 20 of Hsue, it is not provided on a metallic layer.

In the Official Action it is alleged that the organic ARC mentioned at column 4, lines 56-57 is over polysilicon gate electrodes mentioned at column 5, lines 46-49 of Hsue. However, the conductive layer (cited at column 5, lines 46-49 of Hsue) is not formed until after a sequence of steps which would remove the ARC. That is, these steps include the etching of the spin-on-glass leveling layer 20 (which can optionally be a polymer ARC), removing the silicon nitride layer 16 by etching in hot phosphoric acid, and removing the pad oxide 14 by etching in dilute hydrochloric acid (see column 5, lines 31-49 of Hsue). Therefore, by the time the conductive layer is formed on the planarized structure, the spin-on-glass layer (or optional ARC) has long since been removed. Accordingly, Hsue fails to disclose or suggest the provision of an organic ARC on a metallic layer.

In the Official Action, Shan is cited for a suggestion to add chlorine to the gas system Hsue uses to planarize the optional ARC. However, even if chlorine was added to

Hsue's etching gas, there is no suggestion in either reference of providing an organic ARC on a metallic layer. Accordingly, the combination of Hsue and Shan cannot possibly suggest the claimed method.

The Official Action alleges that a person of ordinary skill in the art would have found it obvious to modify the plasma-etching gas mixture disclosed in Hsue by adding chlorine as disclosed in Shan "because chlorine helps to dissociate C-F bonds in the dielectric etch process chemistry and remove polymer residue at the surface of silicon exposed upon etching through the dielectric layer" (Official Action, page 4). The portion of Shan relied on in the Official Action is the "Background" wherein chlorine is mentioned as an additive to an etching gas used in a silicon dioxide over silicon contact etch (column 2, lines 47-62 of Shan). This portion of Shan does not relate to removing an organic ARC and it is not seen why the Examiner considers this portion of Shan relevant to the planarization etching step of Hsue wherein the spin-on-glass layer 20 can be replaced with a polymer ARC. As such, while the Official Action does not provide a sufficient basis for combining the references as suggested in the Official Action, even if the references are combined as suggested in the Official Action there still is no suggestion of the claimed method.

An additional reason one of ordinary skill in the art would not have combined the Hsue and Shan references as suggested in the Official Action relates to the layers exposed by plasma etching. As explained above, in Hsue the reactive-ion etching is carried out to planarize the field oxide. During the reactive-ion etching, the silicon layer remains

covered by the oxide and nitride layers (see Fig. 6 and column 5, lines 10-38 of Hsue). The silicon layer does not become exposed until well after planarization, i.e., through wet-chemical etching in "hot phosphoric acid" followed by etching in "diluted hydrofluoric acid" (column 5, lines 39-43 of Hsue). Because silicon is not exposed during the reactive-ion etching of the optional ARC in Hsue, a person of ordinary skill in the art would not have been led by the teachings of Shan to add chlorine to the gas mixture of Hsue for the purpose stated in the Official Action, i.e., to "remove polymer residue at the surface of silicon exposed upon etching" (emphasis added). Accordingly, it is respectfully submitted that the Official Action does not provide a sufficient basis for combining the cited references.

Another reason why one of ordinary skill in the art would not have combined the Hsue and Shan references relates to etch selectivity. In Hsue, the plasma etch is non-selective, i.e., Hsue specifically states, "etch selectivity between the spin-on glass, the field oxide, and the silicon nitride are about 1:1:1, that is the etching is non-selective" (column 5, lines 18-20). To the extent that the spin-on glass planarization layer is replaced with an ARC layer as indicated at column 4, lines 55-58 and column 5, lines 30-33 of Hsue, the proposed modification of the Hsue etch chemistry to include chlorine would defeat the non-selective nature of the Hsue etch process. That is, the Official Action proposes to add chlorine to Hsue to "remove polymer residue at the surface of silicon exposed upon etching through the dielectric layer" (emphasis added). However, adding chlorine to the Hsue etch process would render the Hsue process unsuitable for its intended purpose of being a non-

selective etch (the Official Action suggests adding chlorine for enhanced etching of the polymer ARC layer). As noted in MPEP § 2143.01, a proposed modification of a prior art reference in an obviousness rejection cannot render the prior art unsatisfactory for its intended purpose. Therefore, contrary to the suggestion in the Official Action, there would have been no motivation to modify the Hsue process by adding chlorine as disclosed in Shan. For at least these reasons, it is submitted that the invention as recited in Claim 1 is patentable over the cited references.

Claim 11 recites a method for substantially preserving a photoresist while removing exposed areas of an organic ARC during IC manufacturing. The process is carried out with a system of etching agents in an ionized state in a reaction chamber of a plasma generating device. The etching agents include at least one fluorine-containing compound, an inert gas, and chlorine. Claim 11 thus reflects an embodiment wherein a patterned photoresist is present with the ARC layer and wherein the etch process is selective. That is, the ARC is etched while the photoresist is substantially preserved.

In contrast, Hsue neither discloses nor suggests a patterned photoresist disposed on an ARC layer. Rather, Hsue discloses an optional ARC spun onto a patterned silicon nitride/field oxide structure wherein the ARC is used as a planarization layer that is then plasma-etched using a non-selective etch gas (column 5, lines 11-30). The addition of Shan's chlorine-etch process does not compensate for the lack of a patterned photoresist layer on the ARC in Hsue's process. Thus, even if Hsue and Shan were combined, there is no suggestion of the method recited in Claim 11. Further, it is submitted that there would

have been no motivation to add such a patterned photoresist layer on the ARC layer in the Hsue process because doing so would defeat the intended planarization purpose of the Hsue process. That is, placing a patterned photoresist on the ARC layer in the Hsue process before etching would lead to less leveling of the surface, contrary to Hsue's goal of planarization. Accordingly, Claim 11 is clearly patentable over the cited references.

Claims 5, 7, 13, 18, and 21 were rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Hsue in view of Shan for the reasons set forth in paragraph 6, on pages 4-5 of the Official Action. However, since these claims depend directly or indirectly from Claims 1 and 11, these claims are also patentable over the cited references.

Applicants submit that the differences between the claimed subject matter and the prior art are such that the claimed subject matter, as a whole, would not have been obvious at the time the invention was made to a person having ordinary skill in the art.

In view of the foregoing, Applicants submit that the present application is in condition for allowance and such action is earnestly solicited.

Respectfully submitted,

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